Incubator Busy Growing Energy Technologies

LAWRENCE Livermore has selected six projects in which Laboratory researchers will work with an industrial partner to advance innovative energy technologies using high-performance computing (HPC). The collaborations, announced in March 2012, will involve GE Energy Consulting; GE Global Research; ISO New England; Potter Drilling, Inc.; Robert Bosch, LLC; and United Technologies Research Center.

The six projects are part of the hpc4energy incubator, a pilot program designed to leverage HPC resources to shorten the time needed for developing and deploying solutions for urgent energy-related problems. "We aim to establish a model for energy technology innovation by bringing together the computational expertise of the national labs with the specialized knowledge of energy-industry companies to tackle real problems these firms face daily," says Laboratory deputy director Tomás Díaz de la Rubia.

The hpc4energy incubator emerged from the 2011 National Summit on Advancing Clean Energy Technologies, which was sponsored by the Howard Baker Forum, the Bipartisan Policy Center, Lawrence Livermore, and others. In October, the Laboratory sought proposals addressing the critical areas outlined in the summit's report: energy-efficient buildings; carbon capture, utilization, and sequestration; liquid-fuels combustion; nuclear energy; and smart grid, power storage, and renewable energy integration. To be considered, proposals had to address a compelling problem whose solution could be achieved through collaborations that combined HPC resources with the expertise available in industry, energy, and computer science. The following sections highlight the winning projects.

Simulating Complex Power Systems

Planning tools used to simulate electric power systems must now consider networks far larger and more complex than those envisioned just a few years ago, and models must include renewable-energy technologies and pervasive control mechanisms. As a result, planning engineers must incorporate an increasing number of scenarios that represent networks in greater detail—models that demand HPC resources. A Livermore collaboration with GE Energy Consulting will deploy GE Concorda PSLF software on an HPC system to significantly reduce the time required for performing contingency analysis.

Improved Analysis of Fuel-Injector Designs

Stringent emission requirements and increased emphasis on reducing fuel consumption have forced automotive and aviation manufacturers to seek new engine technologies and components that must follow an intensive design optimization cycle. In addition, researchers need more detailed information on the spray breakup that occurs during combustion in fuel-injection engines, including statistics such as drop size distribution, penetration, spray cone angles, and spreading rates. The collaboration between GE Global Research and Livermore is demonstrating that virtual prototyping using HPC can reduce the number of design cycles and thus the cost and time to market for new fuel-injector technologies.

System Reliability Gets a Boost

Ensuring the reliability of a region's electric power system is a critical responsibility for ISO New England. Although renewable resources can provide low-emission energy, the variability and uncertainty of these resources pose challenges for reliable power generation and transmission. In this project, a team from ISO New England is tapping Livermore's HPC expertise to enhance operating procedures for the region's electric power system and to develop effective risk-management methods that incorporate renewable energy resources.

Drilling Down to the Details

The thermal spallation drilling systems developed by Potter Drilling, Inc., rely on the thermal expansion of a superheated liquid to eject earth particles and thus drill boreholes more efficiently. These systems can increase well performance while reducing drilling costs and investment risk. However, much of the knowledge surrounding thermal spallation drilling is empirical, making system design and optimization difficult. By leveraging Livermore's HPC capability, together with its GEODYN and PSUADE codes, Potter Drilling can examine the thermal spallation process in much greater detail than it could with its own computational resources.

Reduced Emissions and Fuel Consumption

Promising developments such as hybrid fuel systems and advanced batteries for electric vehicles are increasing the use of electric power trains. Nevertheless, liquid-fueled internal combustion engines are expected to remain the mainstream power source of vehicles for the coming decades. As a result, optimizing these engines is the quickest way to reduce national energy consumption while lowering emissions. Engineers from Robert Bosch, LLC, and Livermore experts in multiscale modeling are conducting simulations to better understand the physical processes occurring in advanced combustion engines.

A New Look at Building Efficiency

Commercial and residential buildings consume more than 40 percent of U.S. energy. In fact, a building's energy usage may be up to 30 percent greater than predicted in the original design because of uncertainties in the parameters used to estimate energy consumption. A significant barrier to adopting energy-efficient technologies in new building construction is the lack of tools to quantify uncertainty in the design and delivery process. United Technologies Research Center is using Livermore's computational resources to improve methods for analyzing a building's energy efficiency.

—*Arnie Heller*